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(58) Field of search
H1D

(54) **Electron microscope with interchangeable lenses**

(57) An electron microscope has an objective lens 50 which comprises a lower yoke 51, an upper yoke 52 disposed within the lower yoke and an excitation coil 53.

The lens is removably mounted on a supporting block 54 by means of bolts 55. This arrangement allows difference lenses to be easily substituted for the lens 50 so that the uses to which the microscope can be put are increased. Difference types of objective lens are described.

FIG. 6

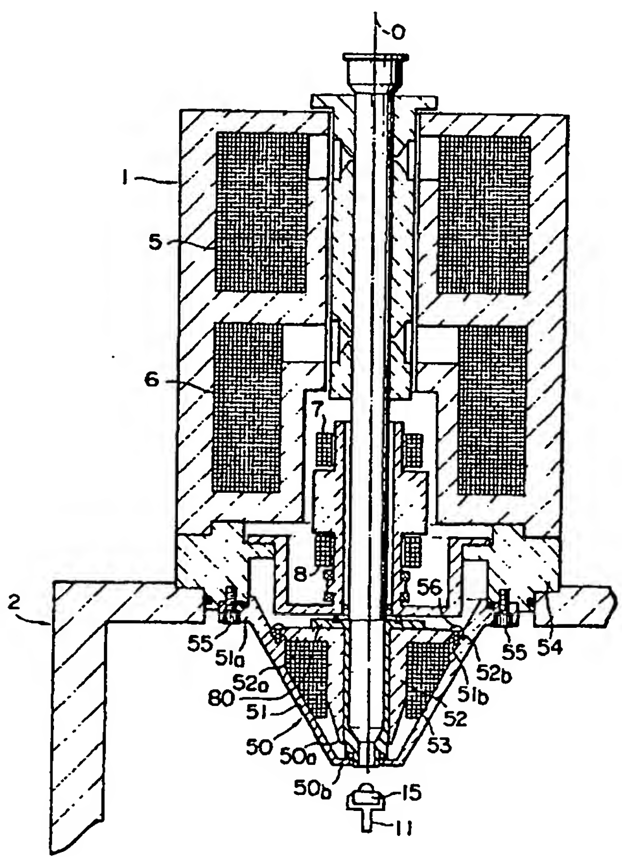

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FIG. 1
PRIOR ART

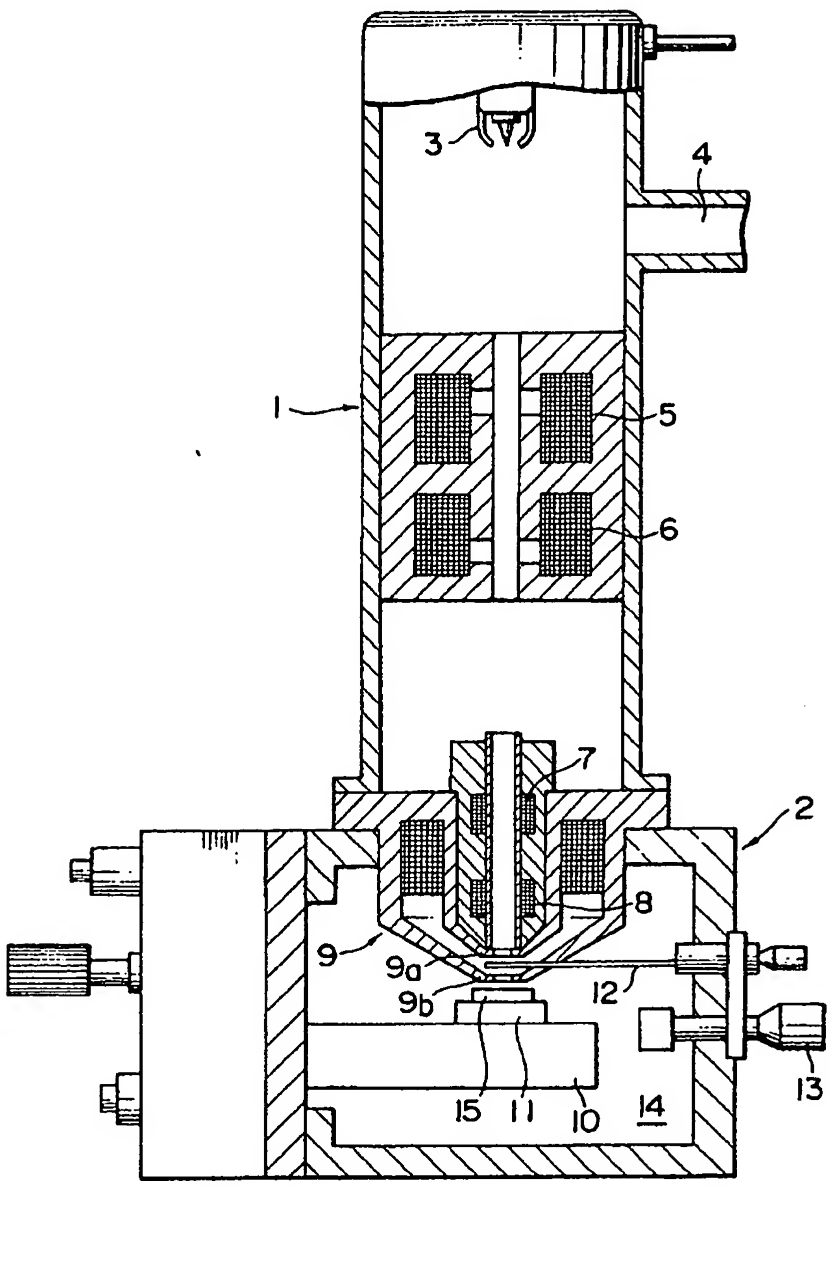


FIG. 2
PRIOR ART

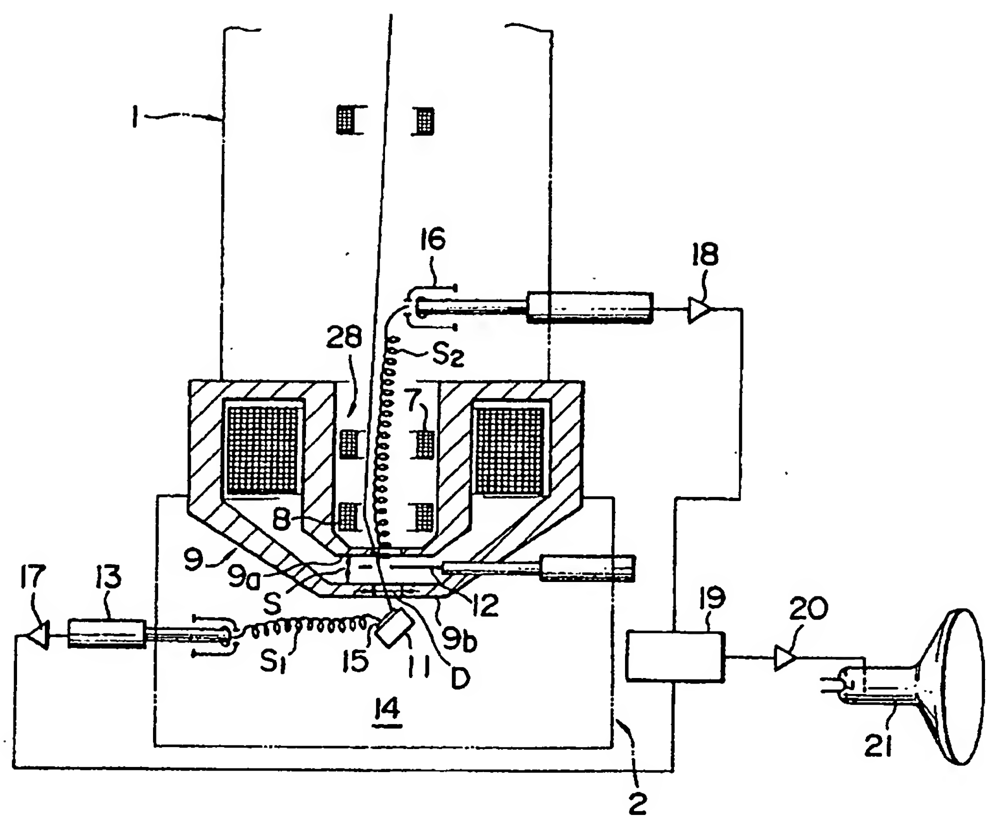


FIG. 3
PRIOR ART

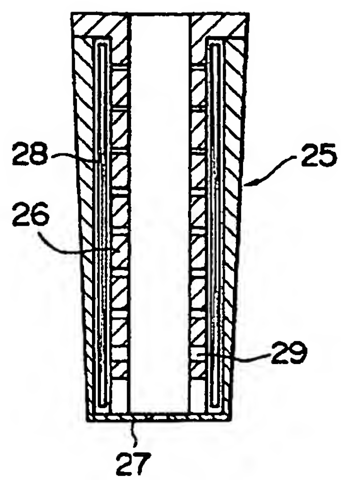


FIG. 4A
PRIOR ART

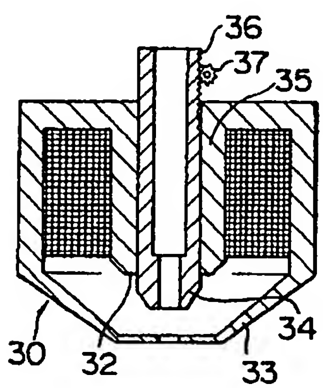


FIG. 4B
PRIOR ART

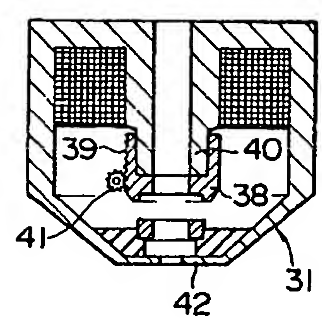


FIG. 5
PRIOR ART

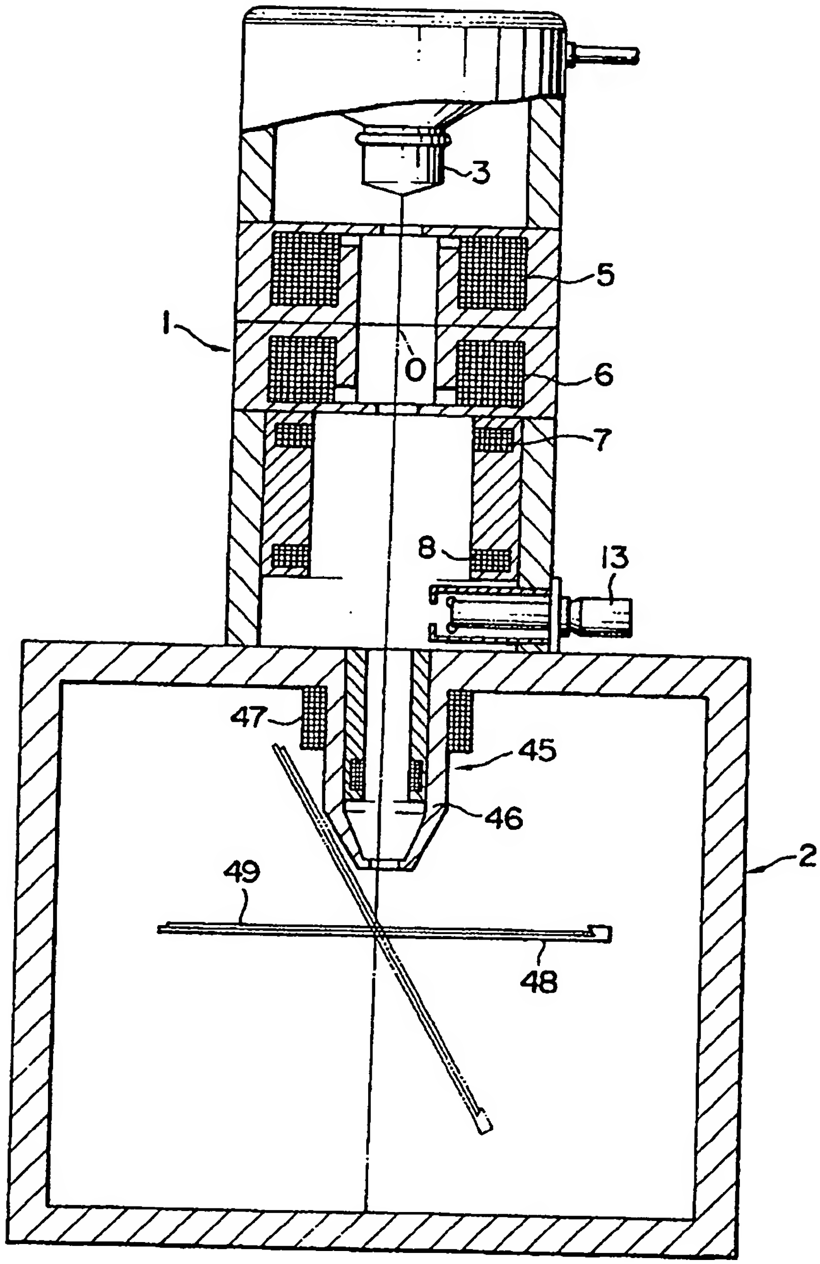


FIG. 6

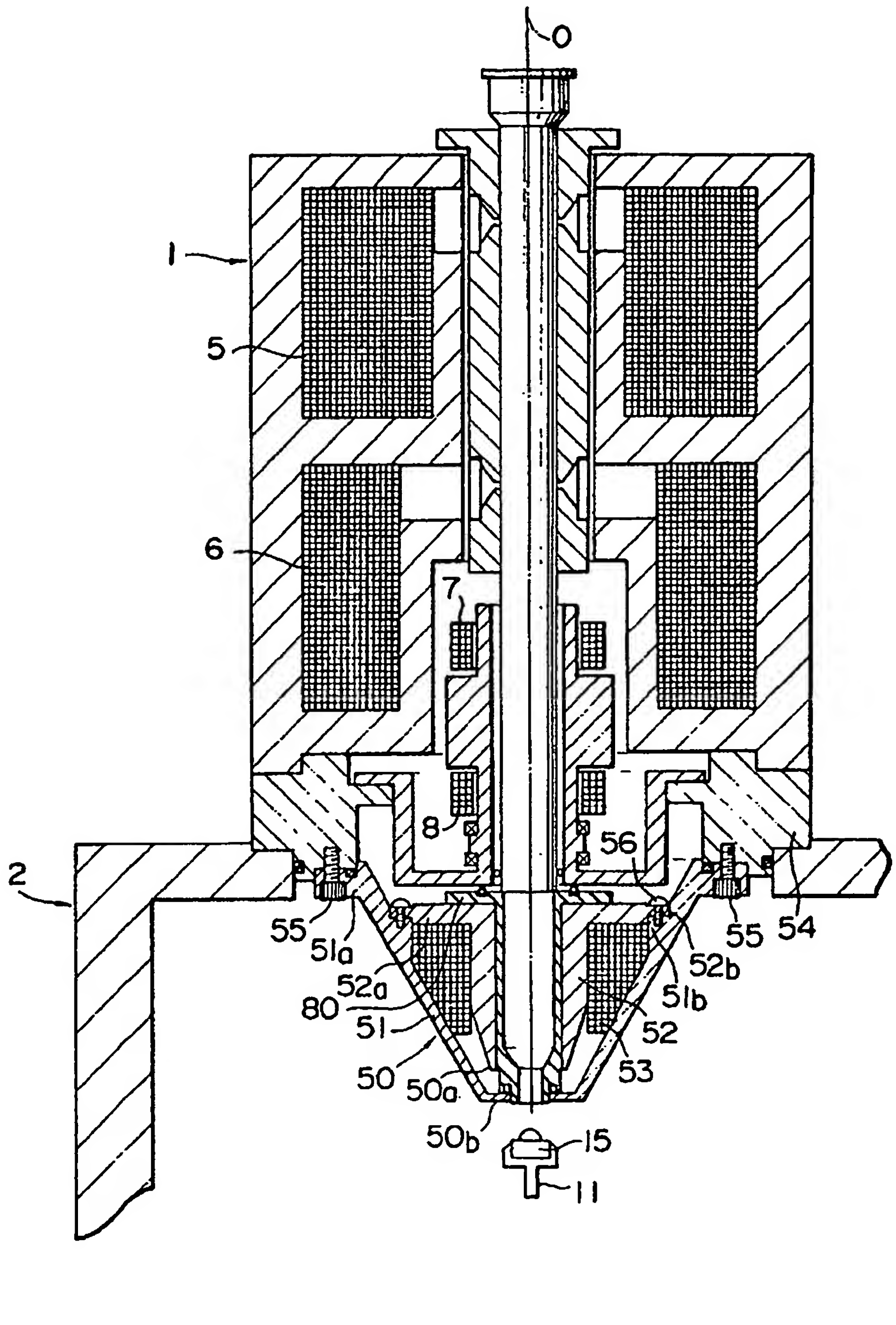


FIG. 7

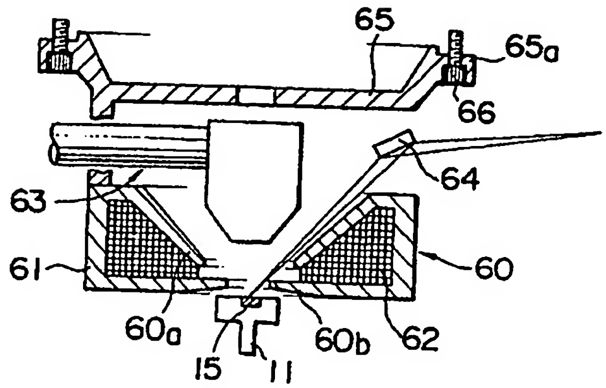


FIG. 8

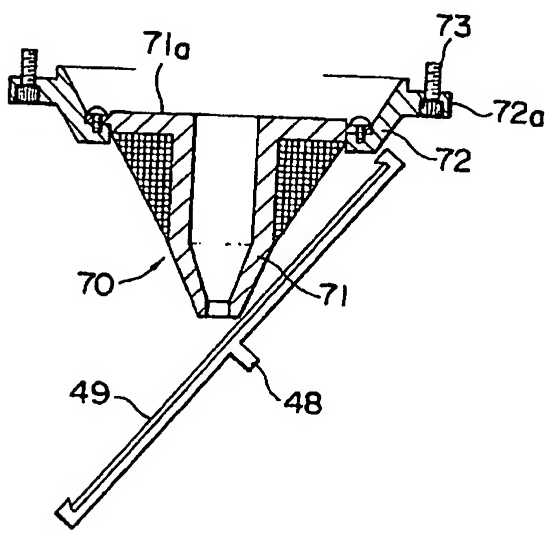
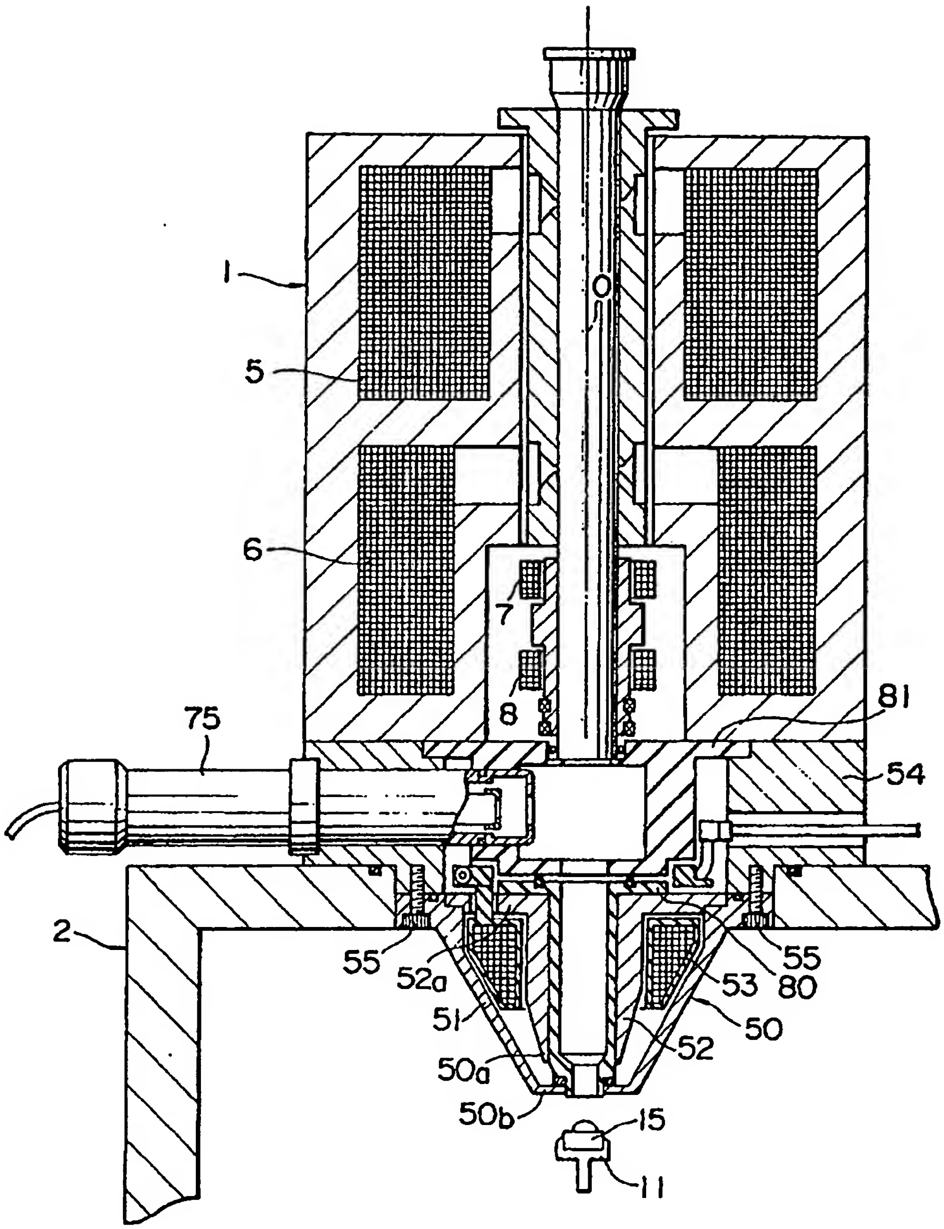


FIG. 9



SPECIFICATION

Electron beam apparatus and electron lens assembly therefor

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention generally relates to a magnetic electron lens assembly as well as an electron beam apparatus incorporation the magnetic lens assembly, and more particularly to an electron beam apparatus of general purpose type which can exhibit various functions so as to be used for numerous applications by exchanging the magnetic or electron lens assemblies in dependence on the intended applications.

2. DESCRIPTION OF THE PRIOR ART

In these years, the electron beam apparatus typified by a scanning electron microscope is used in various fields by virtue of great utility and extensive applicability thereof. As the fields in which the scanning electron microscope is employed, there can be mentioned, for example, biological observations and analyses in which ultra-high resolving power on the order of 10 to 20 Å (angstrom) is required, quantitative and qualitative analyses of speciments through irradiation of X-rays, generation of fluorescent image by making use of reflection and absorption of electrons of an illuminating electron beam, production of electron channeling patterns for determining orientation of crystal, generation of current image and voltage contrast image in a semiconductor device and so forth. In this manner, the scanning electron microscope is used not only for observation of morphological factors but also for analyses of specimens and other various purposes. In addition, there arises recently a demand for the electron beam apparatus which is capable of producing images at an increased resolving power in a range of 100 to 150 Å at an accelerating voltage of 0.5 to 1 KV for examination of IC's as well as masks employed in the manufacture of IC's. Moreover, there exists a demand for observation of IC having a large size of 10 to 20 cm (4 to 8 inches) in diameter in the state inclined at an angle on the or 60°. These requirements can not be satisfied with the present state of technology of the scanning electron microscope.

Primarily, the scanning electron microscope has been developed with a view to realizing a high resolving power and the function which allows the microscope to be used as an X-ray micro-analyzer (XMA). In connection with the usage of the scanning electron microscope as the X-ray micro-analyzer, provision is made such that the accelerating voltage can be varied within a range from 1 KV to 40 KV in correspondence to light and heavy elements contained in specimens so that X-rays can be generated by different elements with the optimum efficiency. Further, in order to reduce the diameter of the electron beam down to ca. 30 Å on the specimen surface with the incident current of 1×10^{-12} A (amperes) for obtaining a secondary electron image of specimen at a high resolving power in addition to making available the beam diameter of 1 to 10μ with the incident current of 1×10^{-8} for the X-ray analysis, there is required an electron beam diminishing lens system. To this end, two stages of condenser lenses are employed in the illuminating system of the microscope. As to the objective lens, it is preferred that an take-off angle at which the X-rays are detected be large in the case of the electron beam apparatus which is to be used as the X-ray macro-analyzer, so that as many spectrometers as possible can be installed. At present, the take-off angle in concern is set in a range of 40° to 53°.

On the other hand, in order that the scanning electron microscope exhibits high resolving power, it is necessary that the accelerating voltage is high and that the working distance is short (i.e. aberrations of lenses are small).

In an effort to satisfy the conditions and requirements mentioned above, the scanning electron microscope of the prior art is commonly implemented in such a structure as shown in Fig. 1 of the accompanying drawings in which an objective lens of a structure illustrated exemplarily in Fig. 2 is employed. For having a better understanding of the present invention, the prior art scanning electron microscope will be described in some detail by referring to Figs. 1 and 2.

A scanning electron microscope shown in Fig. 1 comprises a lens winding column 1 which is composed of an electron gun 3, a first stage condenser lens 5, a second stage condenser lens 6, a first stage scanning coil 7, a second stage scanning coil 8 and an objective lens 9 disposed axially in this order. The scanning electron microscope further includes a specimen chamber enclosure 2 disposed below the lens column 1 and fixedly secured thereto. The enclosuro 1 defines therein a hollow chamber 14 within which a specimen stage 10 is disposed vertically movably below the objective lens 9 together with a movable aperture 12 for the objective lens 9 and a secondary electron detector 13 mounted stationarily. The objective lens 9 is constituted by an upper magnetic pole piece 9a and a lower magnetic pole piece 9b disposed with a predetermined distance from the upper pole piece 9a, both pole pieces 9a and 9b being mounted integrally with the lens column 1. An aperture manipulating member is inserted between the pole pieces 9a and 9b. The specimen stage 10 serves to support a specimen holder 11 and a specimen 15 at a position located below the objective pole pieces 9a and 9b. A numeral 4 denotes an

evacuation conduit connected to a vacuum pump (not shown).

In connection with the objective lens of the scanning electron microscope of the structure described above, it is noted that the yoke of the objective lens 9 has a lower surface portion which is configured in the form of an inverted circular frustum. This configuration is adopted for assuring the take-off angle of X-ray described hereinbefore, so that the scanning electron microscope may serve also as an X-ray micro-analyzer.

On the other hand, in the field of semiconductor technology, there arises a demand for a so-called sampling test through which IC devices, masks, compact discs and the like having a diameter of 10 to 20.5 cm (4 to 8 inches) are visually examined in the course of manufacturing with the aid of the scanning electron microscope. In this conjunction, it will be noted that the IC's or the like which undergo the sampling test are semiprocessed parts to be finished as the commercial products. Accordingly, some restriction is imposed on the sampling test. For example, the IC can not be coated with an electrically conductive material such as gold or the like for preventing electric charging, which is a conventional procedure taken in the ordinary observation of specimen. Under the circumstances, the IC or the like has to be observed with a lowered accelerating voltage on the order of 0.5 to 1 KV. Further, since the IC specimen of a large size is examined in the state inclined at an angle of ca. 60°, the working distance of the objective lens has to be selected as large as ca. 40 mm in the hitherto known scanning electron microscope. Needless to say, the low accelerating voltage in combination with the increased working distance is accompanied by significant degradation in the resolving power.

As will now be appreciated, the range of applications for which the single scanning electron microscope can be used is limited notwithstanding the demand for the multi-function scanning electron microscope. In light of the state of the art, a scanning electron microscope which is designed with emphasis put on a particular one of various functions attracts attention. An example of such scanning electron microscope is shown in Fig. 2 of the accompanying drawings. The scanning electron microscope shown in Fig. 2 shares the basic structure with the one shown in Fig. 1 but is so realized that the image of specimen can be produced with a high resolving power by decreasing the working distance to an extremely small value of approximately 1 to 2 mm. With such short working distance, it becomes however impossible to detect the secondary electrons. To evade this difficulty, at least a pair of secondary electron detectors 13 and 16 are disposed with the magnetic field of the objective lens 9 being interposed therebetween in the case of the scanning electron microscope shown in Fig. 2. Signals produced by these detectors in response to the respective detection of secondary electrons s_1 and s_2 are processed through preamplifiers 17, 18, an adder 19 and an output amplifier 20 separately or concurrently, to be displayed as visual information on a display unit 21 such as CRT. By virtue of the structure shown in Fig. 2, the resolving power can be increased about twice as high when compared with the scanning electron microscope shown in Fig. 1 at a lower accelerating voltage in the range of 0.5 to 1 KV. However, use of the objective lens 9 with the reduced working distance means that the space occupied by the objective lens coil is increased because of necessity to increase excitation of the objective lens, as the result of which the configuration of the lower magnetic pole of the objective lens 9 is forced to be more flat, imposing thus limitation on the angular range in which a specimen can be inclined or tilted. In other words, when it is desired to tilt the specimen, then the working distance must be correspondingly increased. This means that the resolving power or resolution is degraded.

On the other hand, taking into consideration the operation of the scanning electron microscope as the X-ray micro-analyzer, the objective lens has to be implement in a more striking conical form for detecting the X-ray at a large take-off angle. Additionally, it is required to install an X-ray detector of a relatively large size when compared with the available space of the specimen chamber. Additionally, the working distance has to be increased in order to allow the observation of specimen in the inclined or tilted state as described above. Thus, at the present state of the art, the work distance is usually selected in a range of 30 to 40 mm at the expense of the resolving poor. When a large beam current is to be available at a reduced beam diameter as in the case of the micro-analyzer, coefficient of shperical aberration (C_S) becomes significant. In order to reduce the spherical aberration (C_S), it is advantageous to increase a lens gap S or bore diameter D. To this end, there has been developed an objective lens of such a structure as shown in Fig. 3 of the accompanying drawings. Referring to the figure, the objective lens 25 is composed of an upper magnetic pole 26, a lower magnetic pole 27 and an excitation coil 28, wherein gaps 29 are formed in the upper magnetic pole 26 to thereby increase the overall effective gap. However, in case a high resolving power is to be attained at a lower accelerating voltage, chromatic aberration (C_C) provides a more influential factor than the spherical aberration. In order to reduce the chromatic aberration, the gap S as well as the bore diameter D should be decreased. In this manner, the objective lens 25 of the structure

shown in Fig. 3 is disadvantageous in attaining the high resolving power at a low accelerating voltage, although the lens structure is preferred for the function of the X-ray microanalyzer.

Figs. 4A and 4B show other examples of the objective lens employed in the hitherto known scanning electron microscope. In both of the illustrated objective lenses 30 and 31, the upper magnetic pole is mounted movable along the electron beam axis so that the magnetic gap between the upper and lower poles may be varied. More specifically, in the case of the objective lens 30 shown in Fig. 4A, a cylindrical magnetic pole piece 34 is slideably inserted in a bore formed in a yoke of the upper magnetic pole 32. Formed in the outer wall of the cylindrical pole piece 34 is a rack 36 which is engaged with a pinion 37 so that the cylindrical pole piece 34 may be vertically moved through the rack and pinion transmission. In contrast, in the case of the objective lens 31 shown in Fig. 4B, a cap-like magnetic pole piece 38 is slideably fitted on a projection of the yoke constituting the upper magnetic pole 40, wherein a rack 39 formed in the outer wall of the cap-like pole piece 38 is meshed by a pinion 41 so that the upper magnetic pole piece can be effectively moved toward or away from the lower magnetic pole 42. It will be seen that both of the objective lenses 30 and 31 are so constructed that the inter-pole gap thereof can be varied. More specifically, in the application where the working distance is required to be increased, the gap is enlarged to thereby reduce the shperical aberration, while in the application where the accelerating voltage is lowered, the gap is decreased to suppress the influence of the chromatic aberration.

It has however been found that the objective lenses 30 and 31 and both disadvantageous in that the chromatic aberration makes appearance relatively remarkably upon observation of the specimen inclined at an angle of 45° to 60°, involving significant degradation in the resolving power. In reality, the chromatic aberration becomes about twenty times as large as that of an objective lens designed only for use in the low acceleration voltage mode, as described hereinafter in conjunction with Fig. 8.

For allowing observation of a large size wafer at a large angle of inclination of ca. 60° with a low accelerating voltage, it is required to set the working distance as small as possible in order to reduce the chromatic aberration. Fig. 5 shows another scanning electron microscope known heretofore whose objective lens is so constructed as to meet the above requirement. The scanning electron microscope shown in Fig. 5 has a basic structure similar to that of the microscope shown in Fig. 1 except that a specimen chamber enclosure 2 of an increased volume is employed and that the objective lens 45 is composed of an upper magnetic pole 46 and an excitation coil 47 wound on the upper pole piece 46. This objective lens 45 is theoritically equivalent to a structure in which the lower magnetic pole is located at a point at infinity, whereby a large space is available below the objective lens 45 within the specimen chamber 2. A specimen holder 48 and a specimen 49 of a large size such as IC wafer placed below the objective lens 45 can be inclined or tilted at a great angle in a facilitated manner.

The structure shown in Fig. 5 however suffers a shortcoming that the space which the lens coil can occupy is extremely restricted. Another drawback can be seen in the fact that the objective lens 45 of the illustrated structure exhibits a great magnetic reluctance, requiring excitation of intensity about four times as high as that of the objective lens of the conventional scanning electron microscope. As a consequence, operation requiring a high accelerating voltage such as, for example, observation or examination at a high resolving power or operation as the X-ray micro-analyzer is rendered impracticable.

As will be appreciated from the foregoing description, it is technologically very difficult or impossible to satisfy all the requirements imposed on the scanning electron microscope incorporating a particular objective lens.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an electron beam apparatus inclusive of a scanning electron microscope capable of performing an increased number of functions by preparing electron lenses such as objective lenses as assembled lens units which are arranged to be removably or detachably mounted in the electron beam apparatus at a predetermined position.

In view of the above and other objects which will be more apparent as description proceeds, it is proposed according to an aspect of the present invention that an electron lens composed of a yoke member constituting an upper magnetic pole and/or a lower magnetic pole and an excitation coil wound on the yoke member is assembled in an integral or assembled unit, wherein mounting portions are provided in the yoke member so that the assembled or integral lens unit can be removably attached to the electron beam apparatus at a predetermined portion thereof from below. The electron lens unit thus assembled can be used primarily as the objective lens. Accordingly, by preparing a variety of the assembled or integral objective lens units of different designs or specifications, it is possible that various functions or operations such as observation at a high resolving power, observation of large size specimens at an increased resolution or the like can be performed with a single electron beam apparatus.

In an exemplary embodiment of the present invention, the yoke members for the upper and lower poles and the excitation coil are not necessarily assembled in an integral unit but may be so arranged that a part of the assembly, e.g. the yoke for the upper magnetic pole is mounted permanently on the electron beam apparatus while the remaining components are adapted to be removably attached.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will be more apparent from the following description of the exemplary embodiments of the invention taken in conjunction with the accompanying drawings; in which:

Figure 1 is a schematic vertical sectional view showing a hitherto known electron beam apparatus;

Figure 2 is a fragmental sectional view of another known electron beam apparatus provided with a pair of secondary electron detectors;

Figure 3 is a sectional view showing a hitherto known structure of the objective lens employed in the conventional electron beam apparatus;

Figures 4A and 4B are sectional views showing schematically two examples of hitherto known objective lens structures;

Figure 5 is a schematic vertical sectional view showing another example of the electron beam apparatus known heretofore;

Figure 6 is a partially broken sectional view showing an electron beam apparatus according to a first embodiment of the present invention;

Figure 7 is a sectional view showing an objective lens structure accoring to a second embodiment of the present invention which can be employed exchangeably with the objective lens of the electron beam apparatus shown in Fig. 6;

Figure 8 is a sectional view showing an objective lens structure according to a third embodiment of the present invention; and

Figure 9 is a sectional view of an electron microscope having a plurality of secondary electron detectors to which the teaching of the invention can be applied.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the invention will be described in detail in conjunction with the exemplary embodiments thereof.

Fig. 6 shows in a sectional view with a portion broken away a structure of the electron lens assembly or objective lens assembly according to a first embodiment of the invention in the state mounted onto a lens column or barrel of a scanning electron microscope typifying the electron beam apparatus. In Fig. 6, a reference numeral 50 generally denotes the objective lens assembly which differs from the objective lens used in the hitherto known electron microscope in that the objective lens 50 which has been previously assembled in a unit is removably attached to the bottom of the lens barrel from below in a butting manner. More specifically, the objective lens assembly 50 comprises a lower pole yoke 51 made of a magnetic material in a substantially inverted-frustrum configuration flaring progressively from the bottom end toward the top end, an upper pole yoke 52 disposed within the lower pole yoke 51 with a predetermined distance therefrom to define an inner space and constituting a yoke member having a pair of magnetic poles in cooperation with the lower pole yoke 51, and an excitation coil 53 wound around the upper pole yoke 52 and disposed within the inner space. The lower pole yoke 51 has a lower magnetic pole 50b formed at the bottom end and a mounting flange 51a formed at the top end and extending radially outwardly. A plurality of through-holes are formed in the mounting flange 51a for receiving clamping bolts. Further, an annular shoulder 51b projecting radially inwardly to a small extent is formed in the inner wall of the lower pole yoke 51 at an intermediate portion thereof.

The upper pole yoke 52 is constituted by a tubular member having a flange portion 52a extending radially outwardly from the top end, wherein an offset portion 52b is formed along the lower peripheral portion of the flange 52a so as to be snugly received on the annular shoulder portion 51b of the lower pole yoke 51. A number of through-holes are formed in the offset portion 52b for receiving fastening bolts.

On the other hand, a supporting block 54 is disposed between the lens barrel 1 and the specimen chamber enclosure 2. This supporting block serves to support the lens column or barrel above the specimen chamber and at the same constitutes a mount on which the objective lens assembly 50 is to be mounted. More specifically, the objective lens assembly 50 is constituted by positioning the upper pole yoke 52 having the excitation coil 53 wounded thereon on the lower pole yoke 51 with the offset portion 52b of the former being aligned with the shoulder portion 51b of the latter. The objective lens 50 thus assembled can then be mounted on the lens barrel 1 by butting the mounting flange 51a against the lower surface of the mount on supporting block 54 and fastening the clamping bolts 55.

For removing the objective lens assembly 50, the bolts 55 are loosened to allow the lens assembly 50 to be dismounted downwardly and taken out externally of the specimen chamber 2.

The other components of the electron microscope are substantially similar to those of the conventional scanning electron micro-

scopes described hereinbefore. Namely, reference numeral 5 and 6 in Fig. 6 denote condenser lenses of first and second stages, respectively, 7 and 8 denote deflecting coils of first and second stages, respectively, and 11 denotes a specimen holder 11 on which a specimen 15 rests. The aperture member is omitted from illustration, since it constitutes no essential part of the invention. It may be disposed at a suitable position. A numeral 80 denotes a spacer member made of a non-magnetic material such as phosphor bronze.

The objective lens assembly 50 described above is of a general purpose type. It will be appreciated that a single electron microscope can be imparted with various functions by preparing a number of exchangeable objective lens assemblies in accordance with contemplated applications of the microscope. Figs. 7 and 8 show examples of the objective lens assemblies which exhibit different characteristics and can be exchanged with each other. More specifically, Fig. 7 shows an objective lens assembly 60 according to a second exemplary embodiment of the invention which is adapted to be used for X-ray analyses. The objective lens assembly 60 comprises a yoke member 61 having an upper pole yoke portion 60a configured in a bowl-like form and a lower pole yoke portion 60b which is substantially flat. An excitation coil 62 is accommodated within an annular space of a substantially triangular cross-section defined between the upper and the lower yoke portions 60a and 60b. The objective lens 60 thus constituted is securely connected to a mounting arm 65 having a mounting flange 65a at which the objective lens assembly is fixedly mounted on a mount block 54 (Fig. 6) of the microscope by means of the clamping bolts 66. A reference numeral 63 denotes an optical microscope for observing optically a specimen, and a numeral 64 denotes an X-ray detecting element disposed at a position deviated laterally from the electron beam axis.

Fig. 8 shows an objective lens structure according to a third embodiment of the present invention which is so constructed as to allow observation of speciments with a high resolving power at a low accelerating voltage as in the case of the objective lens shown in Fig. 5. This objective lens denoted generally by a numeral 70 is constituted by a single magnetic pole 71 which is coupled to a mounting member 72 having a mounting flange 72a at which the objective lens 70 is securely mounted onto the lens barrel 1 by means of bolts 73 exchangeably with the objective lens assembly 50 or 60 described hereinbefore. Disposed below the objective lens 70 is a specimen holder 48 tiltable over a large angular range so that a specimen 49 of a large size such as an IC wafer can be observed. With the structure of the objective lens 70, a resolution of 50 Å can be attained with the working distance of 1 to 2 mm at an accelerating voltage of 1 KV. In that case, excitation power required for the objective lens 70 is on the order of 1400 AT. It is however noted that excitation power of 4500 AT or more is required for increasing the accelerating voltage to 10 KV, which means that the objective lens 70 can not be used in the ordinary scanning electron microscope.

Fig. 9 shows a scanning electron microscope according to a further embodiment of the invention in which a second electron detector 75 is disposed above the objective lens assembly 50 of a structure similar to the first embodiment of the invention in addition to (or as the alternative of) the secondary electron detector 13 (refer to Fig. 2). A numeral 81 denotes a block defining a secondary electron detection chamber. With the structure shown in Fig. 9, those electrons trapped within the objective lens 50 (as indicated by a symbol S_2 in Fig. 2) upon observation of the specimen 15 with the working distance set at an extremely small value can be detected by the second secondary electron detector 75, whereby the overall detection efficiency of the scanning electron microscope can be enhanced.

In the foregoing, it has been described that the objective lens assembly 50, 60 or 70 include the yoke constituting the magnetic pole and the excitation coil as the fundamental components. It will however be appreciated that an astigmatism correcting coil and/or a scanning coil may be additionally incorporated in the objective lens assembly for enhancing the function thereof. Further, a cooling yoke disposed to enclose the excitation coil may be employed for cooling the objective lens which may otherwise be heated up by heat generated through excitation of the objective lens.

It should be added that although the illustrated objective lens assembly is implemented in an integral unit including the yokes constituting the upper and lower magnetic pole pieces and the excitation coil, the invention is not restricted to such integral structure. For example, in the case of the objective lens assembly shown in Fig. 6, the upper pole yoke 52 may be permanently mounted on the mount of the lens barrel or column (or alternatively it may be made integrally with the latter), while the remaining components, that is, the excitation coil 53 and the lower pole yoke 51 may be removably secured to the upper yoke 52. In other words, the phrase "objective lens assembly" does not always mean an integral complete structure of the objective lens encompass but encompass the sub-assembly of the objective lens such as a combination of the lower pole yoke and the excitation coil, as mentioned above.

As will be appreciated from the foregoing description, there has been provided accord-

ing to the invention an electron lens assembly such as an objective lens assembly which includes at least a yoke constituting a magnetic pole piece and an excitation coil wound around the yoke and assembled as a unit which is adapted to be removably or detachably mounted on the lens column of the electron beam apparatus at a predetermined position. By preparing a variety of the electron lenses having different functions or operation characteristics in accordance with contemplated applications, it is possible for the electron beam apparatus to perform various desired functions merely by exchangeably mounting the corresponding electron lens assembly. In other words, a single electron beam apparatus can satisfy substantially all the various requirements imposed in dependence on applications. Thus, there has been provided an electron beam apparatus which has a significantly enhanced performance and which is inexpensive from the economical viewpoint. As described hereinbefore in conjunction with the state of the prior art, most of new demands for the electron beam apparatus is relevant to the structure of the objective lens. When an objective lens of a novel structure is developed for meeting a new demand, such novel objective lens can be used in the existing electron beam apparatus according to the teaching of the invention. Thus, it is apparent that the present invention provides great advantages and conveniences to the manufactures as well as users.

CLAIMS

1. An electron lens assembly, comprising at least a yoke constituting a magnetic pole, an excitation coil wound on said yoke to constitute an assembled unit, and a mounting portion provided at said yoke, wherein said assembled unit is mounted on a mount of an electron beam apparatus detachably by way of an underlying specimen chamber.

2. An electron lens assembly according to claim 1, wherein said yoke includes a lower pole yoke portion and an upper pole yoke portion mounted on the inner side of said lower pole yoke portion with a predetermined space defined therebetween, said lower and upper pole yoke portions cooperating to constitute a pair of magnetic poles, wherein said coil is accommodated within said space.

3. An electron beam apparatus, comprising:

a lens column incorporating an electron gun, condenser lens means, deflecting coil means for causing an electron beam to scan two-dimensionally a specimen, and objective lens means;

a specimen chamber connected to said lens column at a bottom end thereof and accommodating a specimen stage on which said specimen is disposed; and

radiation detecting means for detecting radiation emitted by said specimen;

wherein said objective lens is implemented in an assembled unit which can be detachably mounted on a mount provided at the bottom end of said lens column in butting relation.

4. An electron beam apparatus according to claim 3, wherein said objective lens means includes at least a yoke constituting a magnetic pole piece and an excitation coil wound on said yoke to thereby constitute an assembled unit, said yoke being provided with mounting means, said assembled unit being detachably attached to said lens column through said mounting means.

5. An electron beam apparatus according to claim 4, wherein mounting and removal of said objective lens assembly are performed by way of said specimen chamber.

6. An electron beam apparatus according to claim 5, wherein said yoke of said objective lens assembly includes an upper pole yoke portion constituting an upper magnetic pole, an excitation coil and a lower yoke portion constituting a lower magnetic pole, said upper and lower yoke portions being physically separated from each other, said upper pole yoke portion being integrally secured to the mount of said lens column, while said lower pole yoke portion is detachably secured to said mount in a butting relation.

7. An electron beam apparatus according to claim 3, 4 or 5, wherein said objective lens means includes an astigmatism correcting coil and/or a scanning coil.

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